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COPPER TUBE ANTENNA and Other Things by John G Hackett . . .

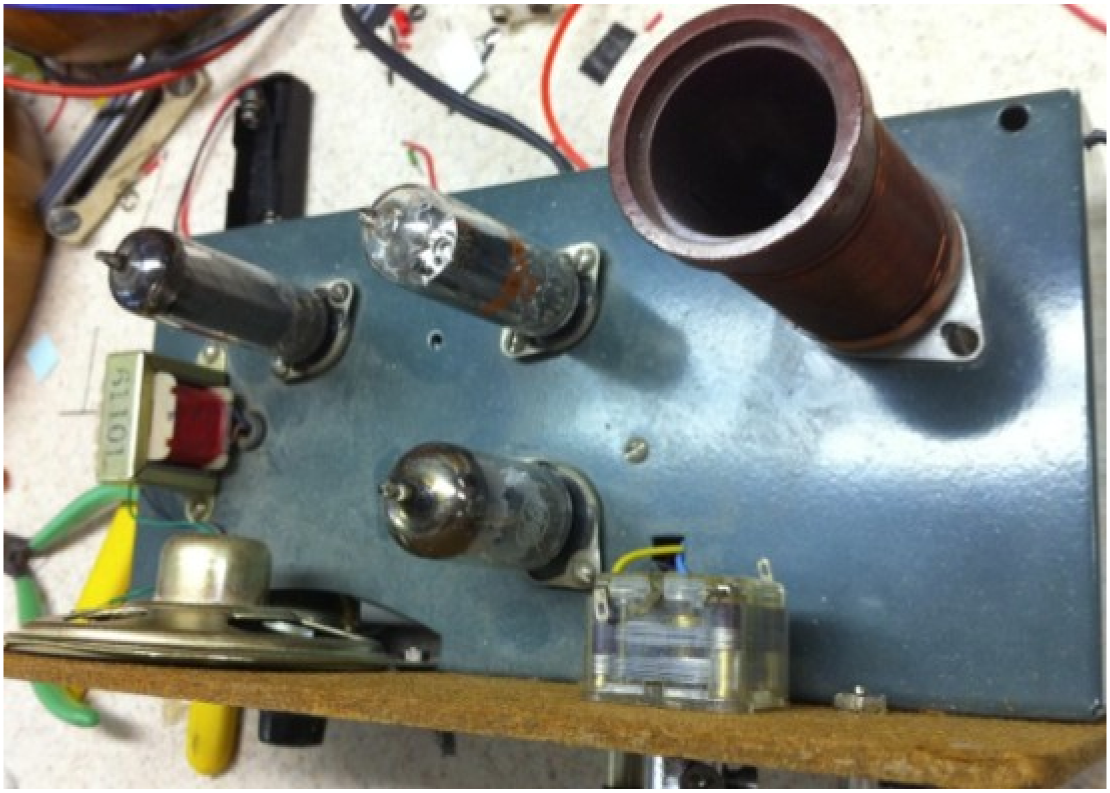
Hallicrafters Radio

I have been dabbling in simple radio for the last 4-5 years, in dribs and drabs as time permits. Mostly I browse the internet looking for insights, but a ham radio friend of mine has been helping me. We did some troubleshooting on an All-American-Five AM/SW Hallicrafters radio from 1952 that my father gave me decades ago, using an RF generator and a nice scope that I've had for awhile. I replaced the tubes with known good ones, and the problem turned out to be that after the old wax caps had been replaced c1980, the coils hadn't been re-tuned. It took me days and days to finally figure that out, with the help of the good schematics that came with it. Even ret-uned the radio was marginal -- stations back then transmitted with more power than today. So I added a Ramsey SA7 broadband pre-amp kit (+16db) and that made a considerable difference!

The Regenerative Radio

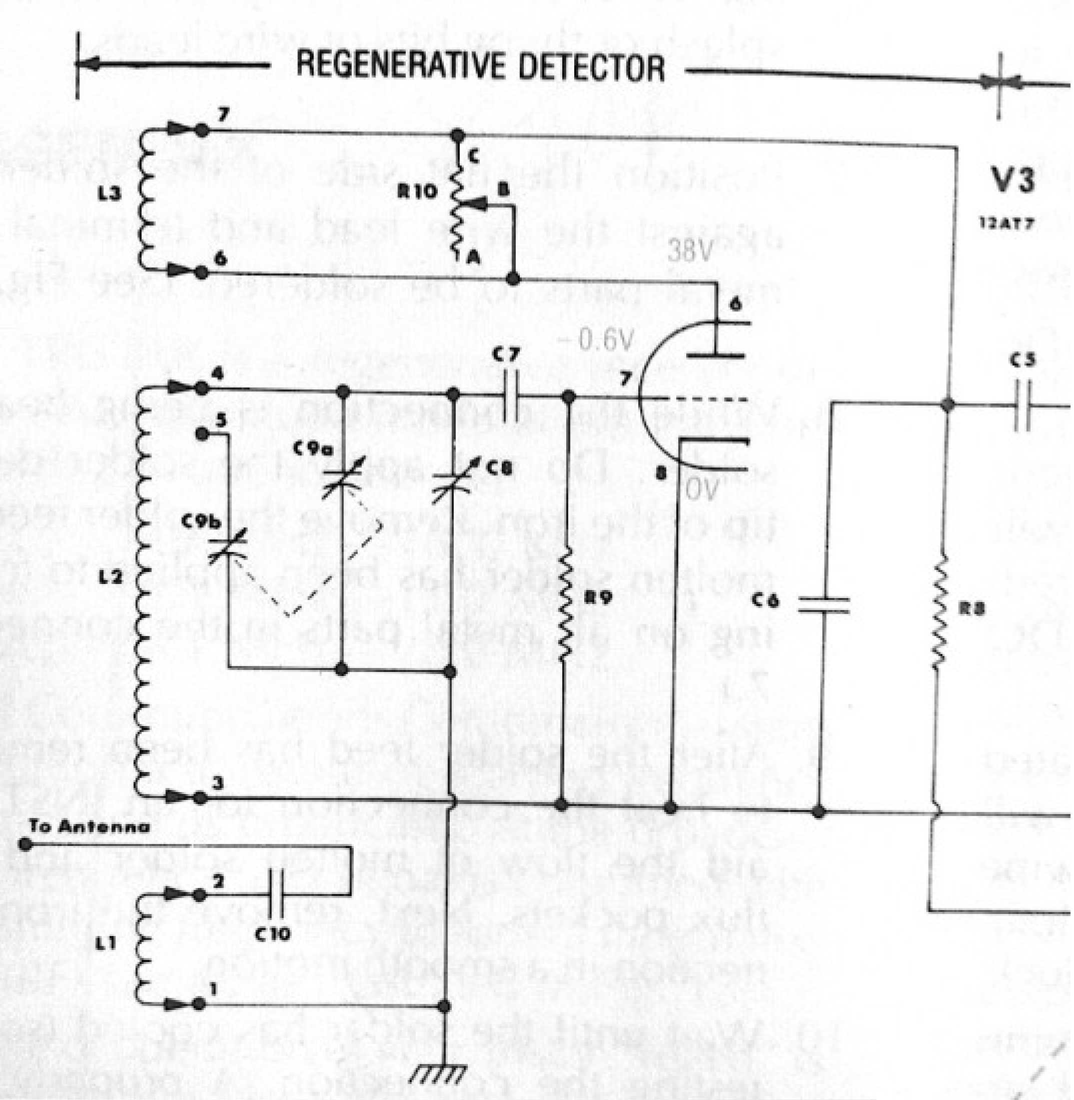
My friend's basement is a debris field of old radio parts and gadgets, so he gave me this long-ago completed radio kit to tinker with. I thought I might renovate it into something classy, in a new cabinet. A nice wooden box perhaps?

I started out by adding the vernier tuning dial and a 10-turn pot for regeneration (not band-spread as shown on the faceplate, which is fixed internally). These improvements made the tuning and regeneration ***much*** easier to control, but reception was just so-so with a temporary 10' wire antenna. The regeneration amplification is very touchy, but I can hit it so precisely now that I don't need to fiddle with it.



If any of your readers are curious, here is the regen detector circuit and description of function:

1975 Graymark 511 Tristar Regenerative radio:
R9 = 2.2M, R10=300 (now 10-turn), R8=47K,
C10=470 pF, C9 tuning=0-269 pF, C8 trimmer=0-20pF, C7=100pF, C6=.0047uF,
L1=L3=5 turns enameled wire on 1.125" core , L2=95 turns (no inductance values were given).



When a RF signal flows in the L1 winding, it creates a varying magnetic field around winding *L2 (tuning winding),* which is positioned very close to L1. This causes a current to be induced into L2 by transformer action. L2 couples the signal to the control grid of tube V3. This signal is then detected and amplified, and causes a fluctuating dc current to flow in the plate circuit of V3. Winding *L3 (tickler winding)* is connected in the plate circuit, and is also positioned very close to L2. The fluctuating dc current in the plate circuit induces a current back into winding L2, that is in-step, *or* in-phase, with the current induced by L1. This condition is known as *regeneration*. This regenerated current is added to the original current and has the effect of increasing the strength of the RF signal to the grid of V3. If this regeneration current becomes too great, the circuit will go into *oscillation,* which will be heard in the speaker as a loud squeal. Potentiometer R10 is used to control this regneration current.

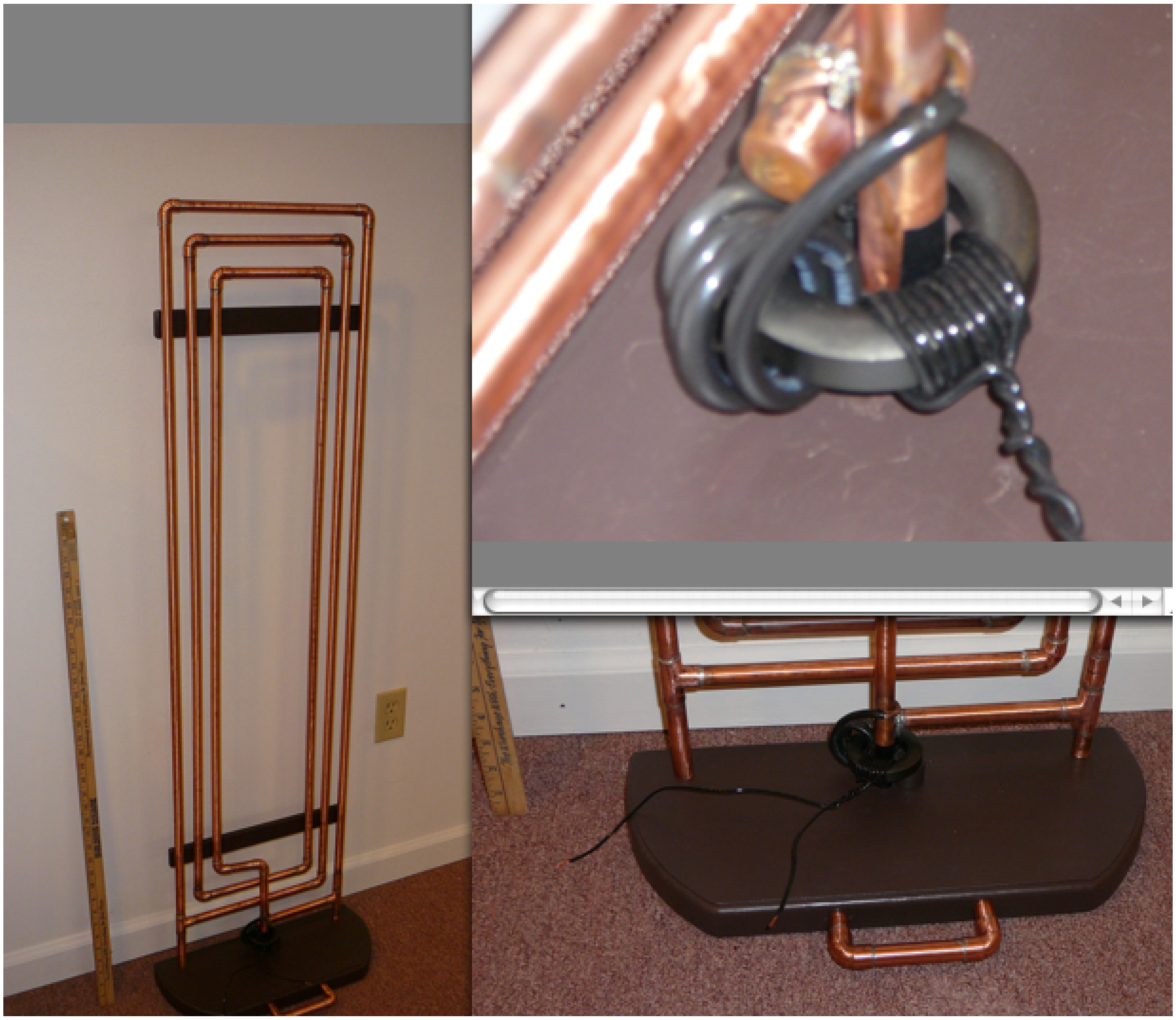
Copper Tube Antenna

Based upon the work done by http://www.am-dx.com/loopant.htm and others, I decided to experimentally build a copper tube antenna for DX-ing. The antenna needed to sit on a table and be rotatable by the simple expedient of grabbing its handle and maneuvering it around on its felt pads. This required that the width be limited, but height wasn't a problem... up to an 8' ceiling level from a table top, of course. I designed and tested the antenna *with* the radio piece by piece, trying every variation I could think of and observing the volume change of my strongest stations. I stopped at three loops because I didn't want to narrow the bandwidth of the antenna too much (AM-DX used *one* loop for this reason). My prior experience with a purchased tuned-loop antenna (30-50 loops?) showed wonderful gain but extremely narrow bandwidth -- I had to tune the All-American Radio to the station first by wire antenna, then switch in the loop and tune it, otherwise I could never align both tuners to the same station. I didn't want to deal with that complexity.

The toroid is the same Amidon FT-240-77 that AM-DX recommends. All of the solder joints were done with cleaned copper, flux, and silver solder. Note the copper tubes near the toroid do not touch, 4 loops of 8-gauge wire complete the connection. The secondary is 9 loops of 14-gauge wire. Everything was live-optimized *on and for this radio* -- the length of the copper, the number of loops, their tightness-looseness around the toroid, the number of loops of the primary and secondary, twisted-wire post-secondary (not a factor), the absence of a tuning capacitor at top, bottom, mid-loop, cross-ways, whatever -- it made no discernible difference. This antenna easily outperformed a 40' long wire antenna run along the ceiling of my basement in the same plane of the loops.

For display purposes ('antenna as art') I hand-sanded the 1/2" copper with 400-grit paper after final assembly and sprayed it with clear gloss acrylic so that it wouldn't tarnish. Three vertical oak dowels in the base support the copper. The oak cross pieces keep the copper tubes aligned, and short #6 stainless steel screws attach them into the back side of the copper.

Now the little regenerative radio strongly (allowing for its 1/2 watt audio amp) picks up 4-5 stations, and perhaps a half-dozen more passably well. A few more stations are very faint. Again, this is in my basement fully below ground level. The antenna appears to work equally well across the entire AM spectrum, but I have no way to measure that and stations are not equally distributed. I can't judge the noise level, but it seems reasonably quiet.



I'm going to dress up those loose secondary leads someday, but I haven't decided what would look best. Gray 5-way posts, probably.

I can't even guess at the impedance of this antenna, and I don't know how to measure it. I don't have a LCR meter, although I'd like one someday. I *am* confident that this antenna+radio system is mutually well-optimized, but I have no idea why it is. I have a Kenwood R-1000 radio I want to try out with it -- that's my next step, in fact. It has a signal strength meter and an attenuation switch which should give me a clue as to gain relative to a long wire.

I assembled a second Ramsey SA7 pre-amp kit this past weekend to try to improve reception. That's cheating, I know, but I was curious. Unfortunately this one is behaving oddly and I can't see anything amiss, 1 MHz in (confirmed by scope) is producing 70 MHz out. Weird. Ramsey hasn't replied to my inquiry and scope trace photos. Is 10mV an outrageously large test signal into a pre-amp? I was getting 200mV out.

A plea to readers : Overall impressions? Suggestions? Thoughts? Tests to perform? Magic words? Would an ATU be useful? Etc.? - email here

Thanks !

John Hackett
(April 2015)

Thank you for your email and fascinating descriptions. To be honest, I cannot add a lot to your copper tube antenna project as I have never made an antenna quite like that. I will say that you have made a very neat and impressive job!

I am quite surprised that it works so well, being an un-tuned device and so not resonant on the required frequency. I suppose that this would be compensated for if the pre-amp could be included. It would be an interesting solution.

I cannot be certain as to why you get 70MHz out for a 1MHz input, but maybe there is some parasitic / self-oscillation occurring? Perhaps some ferrite beads in strategic places could help - e.g. on input and output leads and on the semiconductor leads too. 10mV is a strong signal, but perhaps not as strong as you may expect to encounter, but nevertheless, maybe it is overloading the preamp circuit? You could try an attenuation pad. Perhaps some passband filtering between the aerial and the amp could help - but that's getting rather complex.

Thanks again for the super information - I hope someone will read the page and be able to offer us some additional comments!!

Best wishes, Mike.

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